

DOCUMENT RESUME

ED 247 497

CG 017 657

AUTHOR Burke, Deborah; And Others
TITLE Semantic Priming during Sentence Processing by Young and Older Adults.
SPONS AGENCY National Inst. on Aging (DHHS/NIH), Bethesda, MD.
PUB DATE Nov 83
GRANT NIA-1-R01-AG0452
NOTE 20p.; Paper presented at the Annual Scientific Meeting of the Gerontological Society (36th, San Francisco, CA, November 17-22, 1983).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Age Differences; Aging (Individuals); Cognitive Processes; *Comprehension; Gerontology; *Language Processing; Older Adults; *Retention (Psychology); *Semantics; Young Adults

ABSTRACT

Two divergent views of linguistic ability in adulthood currently exist. One view maintains that verbal ability is preserved in old age, while the other view maintains that verbal ability declines, especially comprehension. To analyze the effects of semantic priming during sentence processing by 30 younger adults (mean age, 25 years) and 30 older adults (mean age, 69 years), three studies were conducted. In the first study, lexical decision latencies for words that were related to a preceding sentence were examined. In the second study, the position of the priming word for the lexical decision target was varied. In the third study, subjects read a sentence which was constructed to bias a particular semantic feature of a target word in a sentence, or no particular feature. In the first experiment no evidence of age-related changes in semantic priming processes, which are believed to be a fundamental component of comprehension, were found. In contrast, older adults did have more difficulty than younger adults in remembering the sentences they had read. In the second experiment no evidence of age-related changes in the nature of semantic processes were found. However, there was some indication of possible age changes in the temporal course of these processes. Finally, data from the third study demonstrated quite clearly that older adults did spontaneously make inferences during reading. These studies point out the importance of using appropriate techniques to separate semantic and retention processes in the study of comprehension. (BL)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED247497

Semantic Priming During Sentence Processing

by Young and Older Adults

Deborah Burke

Rose Marie Harrold

Penny Yee

Pomona College

Claremont Graduate School

University of Oregon

Paper presented as part of a symposium entitled, "Age-Related Changes in Semantic Processes During Language Comprehension and Retention" at the meeting of the Gerontological Society of America, San Francisco, November, 1983.

A copy of this paper may be obtained from Deborah M. Burke, Department of Psychology, Pomona College, Claremont, CA 91711. This research was supported by grant 1 R01 AG0452 from the National Institute on Aging.

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

- ☒ This document has been reproduced as received from the person or organization originating it.
- ☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

Deborah Burke

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

C6017657

Semantic priming during sentence processing
by young and older adults

There are two divergent views of linguistic ability in adulthood. One view is that verbal ability is preserved in old age and the other is that there is a decline in verbal ability, especially comprehension. We believe that these divergent views can be resolved by distinguishing among the mental operations involved in linguistic tasks. In particular, our analysis of the aging literature suggests that older adults have little trouble understanding language, but that they do have difficulty remembering what they have understood.

Consider first the findings from studies of semantic processing that do not require retention of new information. Knowledge of word meanings as measured by vocabulary tests appears to be stable in later adulthood. Indeed, Botwinick (1978) called "a classic aging pattern" the persistent finding on intelligence tests that if older adults showed losses on verbal subtests they were only slight, while declines on performance subtests are common. The organization of knowledge in semantic memory also appears to be stable as young and older adults give similar free associations to words (Burke & Peters, 1983) and they have similar scripts for common experiences (Light & Anderson, 1983). Semantic activation of meaning appears to be comparable in young and older adults based on studies of word perception by Howard and her colleagues and some from our own laboratory (Howard & Burke, 1983; Howard, McAndrews & Lasaga, 1981).

In contrast, Craik, Cohen, Simon and others have argued that semantic processing declines in old age (e.g., Craik & Simon, 1980). Their evidence comes from experimental paradigms which require retention. For example, older adults make more errors in answering questions about material which they have just read or heard and this is attributed to impoverished semantic encoding of the material (Cohen, 1979). Indeed, it is argued that older adults have a particular disability inferring information which is implied but not explicitly stated (Cohen, 1979; Craik & Byrd, 1982).

Thus, we see that the divergent views of whether or not verbal ability is impaired in old age are based on studies which involve quite different cognitive operations. Age-related deficits may occur only when comprehension is measured by what older adults remember from what they have read. Using such techniques, it is difficult to distinguish between processes involved in comprehension, and memory processes involved in retention of comprehended material. Because of older adults well documented problems in retention of new information (e.g., Burke, & Light, 1981), it would seem more appropriate to study aging and semantic processing using techniques which do not require retention. However, few studies using such techniques have involved more than single words. Thus we have carried out a series of studies designed to analyze young and older adults' comprehension of sentences "on-line", that is, as they are being read. Immediately after our subjects read a sentence, they made a decision as to whether or not a target stimulus was a word, i.e., the lexical decision task. Older and younger adults have faster RT when the target word is semantically related to a preceding word (Howard et al., 1981). Here we examined semantic priming of a target word by a preceding sentence. Faster response times for words semantically related to the preceding sentence would indicate semantic priming based on semantic analysis of the sentence.

Before turning to our experiments, let us consider how priming is involved in comprehension. Priming effects are attributed to semantic activation processes. Perception of a word activates corresponding concepts in memory so that the meaning becomes available, and the activation spreads to related concepts, priming them so that they are more accessible (e.g., Collins & Loftus, 1975). When a word corresponding to a related concept is presented, as when a lexical decision target follows a related word, the target will be perceived more rapidly because of the priming. For words in a sentence, the semantic domains that are primed go beyond those related to individual words and include a schema for the situation expressed

in the sentence as a whole. The activation of conceptual schemata to account for the situation expressed in a sentence is the basis for comprehension (e.g., Rumelhart, 1977). According to this model of comprehension, concepts represented explicitly by words in the sentence would be activated within the relevant schema, whereas concepts represented in the schema but not stated explicitly in the sentence would be primed. Thus, this model can account for the inference processes which are so critical in comprehension for knowing what is implied but not explicitly stated.

In the first experiment we examined lexical decision latencies for words that were related to the preceding sentence in one of three ways. As shown in Table 1, in the Whole sentence condition related targets are related to the episode described in the sentence as a whole, but not to any single sentence word. In the Associated word condition, related targets were related to only one word in the sentence but not to the episode as a whole. In the Instrument condition, the related targets are instruments implied by the action described in the sentence. In the Whole sentence and Instrument conditions priming of the related targets involves inferential processes. If older adults have comprehension deficits particularly in their ability to infer information which is implied but not explicitly stated, then young but not older adults should have faster responses to related than unrelated targets in the Instrument and Whole sentence condition. In the Associated word condition we might expect no age difference in priming effects because older adults have shown semantic facilitation in lexical decisions for pairs of associated words (Howard et al., 1981). However, if older adults have difficulty with semantic processing of sentences, then such semantic effects may be impaired when the priming word occurs in a sentence.

We also assessed whether any relatedness effects are based on automatic or attentional processes. Automatic processes do not involve attention, are unaffected by strategies and expectations and do not interfere with other responses. In contrast,

attentional processes are controlled by the person and do interfere with other attentional responses. Facilitation of related targets could occur here because subjects develop an expectation for related words during the experiment. Such expectancy effects could lead to spurious conclusions about comprehension processes as they are task specific and not necessarily involved in sentence processing outside of the laboratory. Thus we include a control group of subjects who receive the same sentences and targets as the experimental group, but the word targets were always unrelated. If attention is required for faster processing of related targets in the experimental group, then unrelated targets will be slowed because attention has been directed to related targets. In this case, the latency for unrelated targets should be longer for the experimental than the control group.

Ten sentence-target word pairs were constructed for each of the three conditions shown in Table 1. An unrelated target for each sentence was created by randomly re-pairing the sentence with a related target for another sentence within the condition. Sentences were simple and declarative with the average number of words the same in each condition. Pronounceable nonwords were created by changing a vowel in a word matched with a target. Nonword sentences matched target sentences in number of words and grammatical construction. We checked the semantic relation between sentences and word targets by having 31 older adults, not in the main experiment, rate the relatedness of the targets to the sentences. On a 1 to 9 scale with 1 related and 9 unrelated, all unrelated targets were rated 7 or more. As expected, sentences in the Whole sentence and Instrument conditions were significantly more related to their word targets than Associated word sentences, and Associated word targets were judged more related to the priming word when presented in isolation than when in the sentence.

The sentence and targets were presented by an Apple II Plus computer. Subjects sat in front of a video screen and pressed a "no" button to initiate the sentence which appeared one word at a time on the screen at the rate of 250 msec/word. Im-

mediately after termination of the last word the target was presented. Response time was measured from the onset of target to a button press indicating yes or no. The same sentences and targets were used for all subjects. On half the trials the target was a word and on half a nonword. For the experimental group, half the sentences in each sentence target word condition were followed by a related target word and half by an unrelated target. Each target^{was} used only once but equally often as related or unrelated across subjects. For the control group, all sentences were presented with their unrelated targets. A short recognition test containing some sentences from the experiment was also administered.

Our subjects were 30 older adults (mean age = 69 years) and 30 younger adults (mean age = 25 years). In each age group, 20 people were randomly assigned to the experimental group and 10 to the control group. In this and the following studies, the young and old subjects had about the same years of education and vocabulary scores.

Priming effects were calculated as the difference between related and unrelated RT and were significant only in the Instrument condition (See Table 2). While older adults had longer RT overall, age did not interact with any variable. With respect to the issue of the automaticity of priming, comparison of the experimental and control groups' latencies for unrelated targets allows us to evaluate whether automatic or attentional processes produced the priming effect. The Inhibition column in Table 2 is the Unrelated RT minus Control RT. As can be seen, in all cases the Control group had slower RT's, although not significantly. Note that the direction of this difference is opposite to that of an inhibitory effect in which unrelated RT's are slowed.

Finally analysis of d' scores from the recognition test indicated that older adults recognized fewer sentences in the recognition test than younger adults ($p < .001$).

Our results suggest that older and young adults are equally likely to make

inferences about the instruments involved in an action. This conflicts with the conclusions in an earlier study by Till and Walsh (1980) in which the effectiveness of retrieval cues in increasing sentences recall was compared for young and older adults. Retrieval cues represented concepts that might be inferred from the sentences and some of them were instruments. Young but not older adults consistently improved with the cues and Till and Walsh concluded that older adults may be less likely to spontaneously generate inferences at input, and thus are unable to benefit from them at retrieval. However, the retrieval cue paradigm is a questionable technique for investigation of processes occurring during sentence comprehension. For example, an instrument is an effective retrieval cue for a sentence describing an action in which it is typically involved, even when another instrument is explicitly stated in the sentence (Corbett & Doshier, 1978). This suggests that retrieval cues are helpful in generating actions at retrieval even when they have not been inferred during sentence processing. Thus the present conclusions may be inconsistent with those of Till and Walsh (1980) because they measured a retrieval phenomenon whereas in the present study processes at input were measured.

Cohen (1979) also concluded on the basis of retention performance that older adults have deficits in comprehension processes involving inferences. She found no significant age difference in recall of explicit information (although older adults consistently recalled less than younger), while recall of implied information was significantly poorer in older adults. The obvious differences in the retention requirements of Cohen's task and those of the present one could account for the difference in results. First, Cohen's finding of no age differences in recall of explicit information does not indicate that the facts necessary for inferences were equally available to young and older adults. Inferences typically require simultaneous recall of several facts whereas explicit recall tests single facts. Indeed, the age deficit in answering inference questions has been eliminated by making the facts available (Belmore, 1981; Light, Zelinski & Moore, 1982; but see Taub, 1979). Second, at least some of the inferences in Cohen's study appear to

require retention of information through several sentences. In the present study, information relevant for an inference was presented within a single sentence and thus any difficulty older adults may have in retaining facts or inferences during successive material would not constrain comprehension.

While null results must be viewed very cautiously, the finding of no facilitation of related targets in the Whole sentence and Associated word condition does suggest several interesting possibilities about sentence processing. According to our pretest data, sentences in the Whole sentence and Instrument conditions were equivalent in the degree to which they implied their related target words. However, more words had to be processed in the Whole sentence than in the Instrument condition for selection of a schema that included the target. Thus priming of an inference in the Whole sentence condition may require more time and may appear only with a longer delay between sentence and target. An important issue for future research is the relation between the time course of priming for different types of inferences and the time course of semantic processes involved in understanding the sentence.

The lack of priming effects in the Associated word condition is particularly interesting because priming occurs for young and older adults when semantically related words are presented in isolation (Howard et al., 1981). In our study Associated word sentences were carefully constructed so that except for the priming word, sentence words would not be related to the target. The context in which a word appears determines which aspect of its meaning is accessed (e.g., Tabossi & Johnson-Laird, 1980), and thus the semantic interpretation of the priming word may have been biased away from the target word, particularly by the time the target word was presented at the end of the sentence. Indeed Foss (1982) has recently shown that priming does not diminish with intervening sentence words only if the topic of the sentence supports the semantic relation between the priming word and the target. We were, however, troubled by the substantial but nonsignificant difference between related and unrelated targets in the Associated word condition for young but not older adults. In particular it seemed possible that there was a

residual priming effect for young adults, while for older adults the priming effect either did not occur or decayed more rapidly during the sentence words intervening between prime and target. Our second experiment was designed to investigate these possibilities.

In the second experiment, we varied the position of the priming word for the lexical decision target. As can be seen in Table 3, in the short version of a sentence the priming word was the final word and in the long version a three or four word prepositional phrase followed the priming word. We tested two alternative explanations of the Associated word results in the first study. One possibility is that the time course for decay of priming effects differs for young and older adults. Thus the priming word may have primed the related target but this priming had decayed by the end of the sentence for the old while a small nonsignificant effect remained for the young. In this case, we should find priming effects for both age groups in the short condition but for the young only in the long condition.

The other alternative is that interpretation of the sentence constrains the meaning accessed by the priming word and directs it away from the target word. In this case, we would find no priming effects for young or old in either condition.

For the priming words and targets, we selected 48 pairs of associated words from word association norms for young and older adults (Burke & Peters, 1983). Sentences were constructed so that their meaning was related as little as possible to the target. A sentence was used equally often across subjects in its short and long versions and with its related and unrelated targets. Forty-eight sentences followed by nonwords were also constructed. Presentation of sentences was the same as in the first experiment.

The data from 32 young and 32 older adults is shown in Table 4. While there was a main effect of relatedness, post hoc tests showed that the priming effect was significant only for older adults and only in the short sentence condition. However, the interaction of age with relatedness was not significant. These results

do not follow either predicted pattern. Considering first the young adults' data, how are we to interpret the lack of priming effects, since such associated word pairs have been shown in many studies to produce semantic priming when the prime is not presented in a sentence? Recall that the sentences were constructed to bias meaning away from or at least be neutral to the target. The sentential context appears to constrain semantic activation to aspects of meaning consistent with the sentence. While previous studies have shown that sentential context can inhibit irrelevant aspects of a word's meaning, the only investigation of the time course of inhibition has involved homographs, that is, words with very different meanings (e.g., Tanenhaus, Leiman & Seidenberg, 1979). The meaning of the homograph that is incompatible with the sentential context was suppressed within 200 msec after presentations of the homograph. The lack of priming effects for young adults in the short condition suggests that such effects for non ambiguous words may be very rapid as well.

Older adults, however, did show priming effects with short sentences but not with long ones. This pattern of results suggests that older adults may require more time for interpretation of sentence meaning or for sentence meaning to affect word meaning. With long sentences, more time was available because several words intervened between prime and target. Under these conditions priming appears to be suppressed but not when the target follows immediately after the prime. Thus, while the nature of semantic processes involved in sentence comprehension appears to be the same in young and older adults, the time course of these processes may slow with age. However, these conclusions are very speculative and we are in the process of subjecting them to a more rigorous test.

Finally, I would like to consider some more anecdotal data from a third experiment which is still in progress. In this study, subjects read a sentence which was constructed to bias a particular semantic feature of a target word in the sentence, or no particular feature. For example, in Table 5 the first sentence suggests no particular feature of gun, while the second sentence suggests the stickiness

of syrup. At the end of the sentence the target was presented and subjects were to name a characteristic of the target suggested by the sentence and explain why. I will not discuss the data fully here but want to remark on some striking features of the older adults' responses which are relevant to our discussion of comprehension and aging. First, older adults were just as likely as young adults to produce the semantic feature relevant to the sentential context. Consistent with the results of the first two studies, this suggests that older adults have no difficulty with subtle connotations of sentences. But even more compelling were the older adults' explanations. A few examples, each from a different older adult, are given in Table 5. These made it clear that older adults suffered no deficit in inferential processes, and indeed, as illustrated in the first explanation, that they were at times well aware of the distinction between explicit and implied information.

In sum, the first experiment provides no evidence of age-related changes in semantic priming processes which are believed to be a fundamental component of comprehension. In contrast, older adults did have more difficulty than younger adults in remembering the sentences they had read. In the second experiment we again found no evidence of age-related changes in the nature of semantic processes, but there was some indication of possible age changes in the temporal course of these processes. And finally, data from our third study demonstrates quite clearly that older adults do spontaneously make inferences during reading. These studies point out the importance of using appropriate techniques to separate semantic and retention processes in the study of comprehension. We believe that the failure to do so in previous studies has led to conflicting views about the nature of changes in verbal processes in old age.

References

- Belmore, S. Age-related changes in processing explicit and implicit language. Journal of Gerontology, 1981, 36, 316-322.
- Botwinick, J. Aging and behavior (2nd Ed.). New York: Springer, 1978.
- Burke, D. M. & Light, L. L. Memory and aging: The role of retrieval processes. Psychological Bulletin, 1981, 90, 513-546.
- Burke, D. M. & Peters, L. J. Word associations in young and old adults. Unpublished manuscript, 1983. (Available from D. M. Burke, Pomona College, Claremont, CA 91711.)
- Cohen, G. Language comprehension in old age. Cognitive Psychology, 1979, 11, 412-429.
- Cohen, G. Inferential reasoning in old age. Cognition, 1981, 9, 59-72.
- Collins, A. M. & Loftus, E. A spreading-activation theory of semantic processing. Psychological Review, 1975, 82, 407-428.
- Corbett, A. & Doshier, B. Instrumental inferences in sentence encoding. Journal of Verbal Learning and Verbal Behavior, 1978, 17, 479-491.
- Craik, F. I. M. & Byrd, M. Aging and cognitive deficits: The role of attentional resources. In F. I. M. Craik & S. Trehub (Eds.), Aging and cognitive processes. New York: Plenum Press, 1982.
- Craik, F. I. M. & Simon, E. Age differences in memory: The roles of attention and of depth processing. In L. W. Poon, J. L. Fozard, L. S. Cernak, D. Arenberg, & L. W. Thompson (Eds.), New directions in memory and aging: Proceedings of the George Talland memorial conference. Hillsdale, N. J.: Erlbaum, 1980.
- Foss, D. J. A discourse on semantic priming. Cognitive Psychology, 1982, 14, 590-607.
- Howard, D. V. & Burke, D. M. Aging and the semantic priming of lexical decisions. In Attig, M. (Chair), New directions in research on automatic and effortful processing Symposium presented at the meeting of the American Psychological Association, Anaheim, 1983.
- Howard, D. V., McAndrews, M. P. & Lasaga, M. I. Semantic priming of lexical decisions in young and old adults. Journal of Gerontology, 1980, 35, 884-890.

- Light, L. L. & Anderson, P. A. Memory for scripts in young and old adults. Memory & Cognition, 1983, 11, 435-444.
- Light, L. L., Zelinski, E. M. & Moore, M. Adult age differences in reasoning from new information. Journal of Experimental Psychology: Learning, Memory and Cognition, 1982, 8, 435-447.
- Rumelhart, D. E. Understanding and summarizing brief stories. In D. Laberge & J. Samuels (Eds.), Basic processes in reading. Hillsdale, N. J.: Erlbaum, 1977.
- Tabossi, P. & Johnson-Laird, P. N. Linguistic context and the priming of semantic information. Quarterly Journal of Experimental Psychology, 1980, 32, 605-624.
- Tanenhaus, M. K., Leiman, J. M. & Seidenberg, M. S. Evidence for multiple stages in the processing of ambiguous words in syntactic contexts. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 427-440.
- Taub, H. A. Comprehension and memory of prose materials by young and old adults. Experimental Aging Research, 1979, 5, 3-13.
- Till, P. E. & Walsh, C. A. Encoding and retrieval factors in adult memory for implicational sentences. Journal of Verbal Learning and Verbal Behavior, 1980, 19, 1-16.

Sentence-target Condition	Sample Sentence	Sample Targets: Experimental Group		Sample Targets: Control Group
		Related	Unrelated	
Whole sentence	She gave her hungry dog something to chew.	Bone N=5	Nest N=5	Nest N=10
Associated word	That round table is usually in the kitchen.	Chair N=5	Boat N=5	Boat N=10
Instrument	The cook cut the meat.	Knife N=5	Key N=5	Key N=10
Non-word	The waiter wiped the water off the floor.	LAT N=30		LAT N=30

Table 1: Examples of Sentence and Target Stimuli for Experimental and Control Groups in Experiment 1.

Table 2
Mean Response Times (msec) with Priming and
Inhibition Effects for Lexical Decisions
as a Function of Relatedness and Sentence Condition

	<u>Young</u>			<u>Old</u>		
	Response Time	Priming	Inhibition	Response Time	Priming	Inhibition
Whole Sentence						
Related	997			1408		
Unrelated	969	-28	-1	1427	19	-26
Control	970			1453		
Associated Word						
Related	907			1365		
Unrelated	946	39	-2	1361	-4	-28
Control	948			1389		
Instrument						
Related	930			1381		
Unrelated	981	51*	-5	1487	106*	-51
Control	986			1538		
Nonword						
Experimental						
Group	1046			1528		
Control Group	1117			1620		

*p < .05

Note: Priming Effect is Unrelated minus Related RT
Inhibition is Unrelated minus Control RT

Table 3

Examples of Sentences and Target Words for Experiment 2

Sentence Length	Sample Sentence	Related Target	Unrelated Target
Short	When I feel very poorly, I go to the <u>doctor</u> .	Lawyer	Town
	The fire station is located in the center of the <u>city</u> .	Town	Lawyer
Long	When I feel very poorly, I go the <u>doctor</u> for help- ful advice.	Lawyer	Town
	The fire station is located in the center of the <u>city</u> near the huge fountain.	Town	Lawyer

Note: Prime word is underlined.

Table 4

Mean Response Times (Msec) and Priming Effects
for Young and Old Adults as a function of Relatedness and Sentence Length

Sentence Length	Young			Old		
	Related	Unrelated	Priming Effect	Related	Unrelated	Priming Effect
Short	695	714	19	1034	1081	47*
Long	710	728	18	1021	1025	4

*p < .05

Table 5

Examples of Sentences, Targets and Older Adults'
Responses in Experiment 3

Sentence	Target	Subject's Response and Explanation
The store sold the gun at a reduced rate.	Gun	None: You could of inferred that it was old but it didn't say so - or damaged. Because it was sold at a reduced rate
The syrup held the paper napkin to the table.	Syrup	Sticky: Because it stuck the napkin to the table
The rabbit looked out with a hesitant air.	Rabbit	Timid: Rabbit is a little animal. He was a little scared to come out so he peeked out first to see what was - who was around
The bees came from another place.	Bees	Flight: The bees came from another place and in order to do that - a bee's mode of transportation is flight
The child munched the peanuts with loud chewing.	Peanuts	Crunching: Because he was chewing the peanuts. Probably with his mouth open
The woman buttoned up the coat on chilly evenings.	Coat	Warm: Nice warm coat on a winter night, buttoned up to the chin. Keep nice and warm.